STATE OF CONNECTICUT
DEPARTMENT OF CONSTRUCTION SERVICES
Office of the State Building Inspector

November 1, 2011

Louis Free, AIA
Chairman, Codes and Standards Committee
1111 Country Club Road
Middletown, CT 06457

Dear Chairman Free:

Attached please find the Connecticut Residential Fire Sprinkler Working Group Final Report that addresses the issues that the Codes Amendment Subcommittee have raised.

The members of the Working Group will be happy to attend the next Codes Amendment Subcommittee meeting to address any questions you might have regarding our findings.

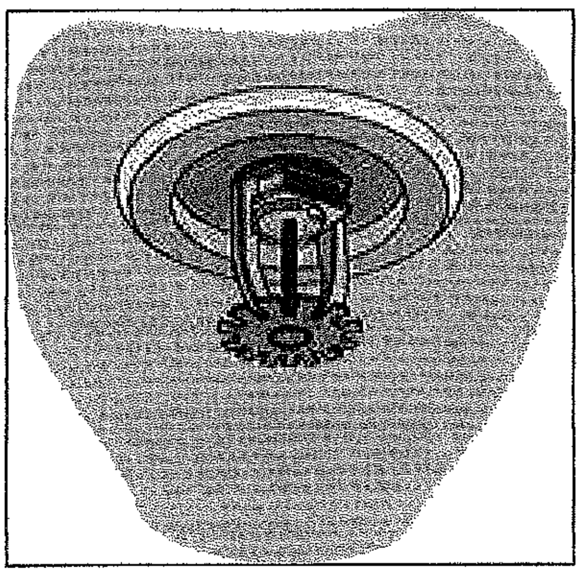
Please let me know when you would like us to attend.

Sincerely,

Daniel Tierney
Co-Chairman

DT:pm
Attachment

Connecticut
Residential Fire Sprinkler Research Working Group



Facts, findings and final report

The Implementation of Residential Fire Sprinkler Systems within One and Two Family Dwellings and Townhouses in Connecticut

On October 13, 2010, the Codes Amendment Subcommittee (CAS) of the Codes and Standards Committee voted to create a separate committee charged with researching the various issues associated with mandating residential sprinklers in one and two family homes and townhouses. In the meantime, the 2009 International Residential Code Section R313 would be deleted from what will be an amendment to the 2005 State Building Code and NFPA 13D would be added to the appendix of that amendment. (By adding it to the appendix, the standard would be applicable to voluntary installations.) After completion of its review of the remainder of the 2009 International Code Council (ICC) family of codes, the CAS could then revisit the sprinkler issue and incorporate it into the building code during the next code cycle. Robert Ross, Director of the Department of Public Safety Division of Fire Emergency and Building Services, offered to coordinate membership and chair a study group (committee) which was accepted by CAS Chair Louis Free.

NOTE: Although the Committee was not asked to address this type of system, Section R313, of the 2009 International Residential Code, allows the installation of the required residential sprinkler system to comply with either NFPA 13D or P2904 of the above code. Section P2904 which is under the plumbing section of the 2009 International Residential Code, and was developed to provide a design and installation method for a fire sprinkler system that will provide an equivalent level of protection as provided by a NFPA 13D system, but without the need for sophisticated calculations and other installation complexities. Even though this is under the plumbing section of the 2009 International Residential Code, the Department of Consumer Protection would still consider this fire sprinkler work and require a license for sprinkler contractors to perform the work unless the homeowner is doing the work within his own single family dwelling. Also, leading manufacturers are developing a residential sprinkler system which incorporates a water mist system.

The following 13 items that this committee addressed and their findings are as follows:

a. Specific historical data on fire statistics for one and two family dwellings as well as townhouses and the age of such homes with an incident. Also statistics on which homes did and did not contain early warning detection such as smoke detectors.

   FINDING: This question was not researched by the committee. The direction of the Codes and Standards Committee was to determine the impact "if" the ICC requirement for sprinklers was adopted here in Connecticut. It was determined that the historical data research could consume a large amount of time to collect and the efforts of this committee would be better served on researching the impact of adoption.

b. The unknown requirements of the State's water purveyors and for individual supply lines, metering, back flow preventers and related annual fees if applicable.

   FINDING: The committee met with representatives from Municipal Water Companies and found that except for backflow preventers, they have different regulations regarding the installation of residential sprinklers. It was concluded that if the sprinklers were going to be required a combined effort from the water companies and the authority having jurisdiction from the municipalities to develop a single standard would be required.

c. The related costs for installation outside of the building footprint for this water service, excavation costs and other related expenses.

   FINDING: The cost would vary depending on the nature of the soil (rock, ledge, etc.). An approximate cost of $2,500 was obtained for a 100 foot long trench with a one inch copper water service pipe installed from the curbside to the foundation. This cost would be offset for newly constructed residential buildings by utilizing the same trench and water service pipe to the home.

d. Estimated financial installation cost (relative to the State of Connecticut construction industry) of the NFPA 13D system inside the residence (installation requirements).

FINDING: The committee decided to use a typical two story 2,500 square foot house with a full basement making the total square footage at 3,750 (plans attached). An AIA committee member agreed to draw up a set of plans that included elevations, floor plans and basement plans. These plans were sent out to a number of sprinkler contractors throughout the State of Connecticut with a letter asking for cost estimates for the design and installation of a standard system installed to the NFPA 13D standard using black iron piping in the basement and CPVC fire sprinkler piping for the house.

The installers and designers were requested to submit two costs, one for the installation of a system on a municipal water system and one for the installation on a well system. The committee received four estimates for the installation, one of the estimates was disqualified for not complying with the requirements; these estimates also included the design cost (see attached).

Based on the information submitted, the average cost of design work for the typical 2,500 square foot colonial is $500.

The average cost for the typical 2,500 square foot colonial on a municipal water system is $6,904 with an average cost per square foot of $1.84.

The average cost for the typical 2,500 square foot colonial on a well system is $6,843 with an average cost per square foot of $1.82.

NOTE: These prices do not reflect any profit margin of the general contractor.

e. Who is the licensed installer who can install this system and how many of such individuals are licensed in Connecticut available to do this work?

FINDING: At this time, Connecticut requires that persons installing a fire suppression system be licensed for such work. The licensed installers are unlimited fire protection sprinkler contractors (F-1) and unlimited fire protection sprinkler journeypersons (F-2) provided he/she is in the employ of an F-1 contractor.

There are 666 licensed F-1 contractors and 854 F-2 journeyperson licensed in the State of Connecticut.

NOTE: A homeowner can install an NFPA 13D fire suppression system without a license if it is installed only within a stand alone single family dwelling (license required for townhouses and two family dwellings).

f. Who can be the responsible individual to design the system? Can a homeowner do this?

FINDING: Section 29-263, of the Connecticut General Statutes, states "In the event that working drawings are used for the installation, alteration or modification of a fire sprinkler system, no state, city, town or borough building official responsible for the enforcement of laws, ordinances or regulations relating to the construction or alteration of buildings or structures, pursuant to section 29-263, shall accept or approve any such drawings or specifications which are not accompanied by evidence of licensure by the state as an automatic fire sprinkler system layout technician licensed pursuant to section 20-304a or are not accompanied by evidence of licensure by the state as a professional engineer in accordance with chapter 391".

g. What are the required annual maintenance and inspection requirements of an NFPA 13D residential sprinkler system? Can a homeowner do this or a specialized tradesman?

FINDING: The occupants of a home with a sprinkler system should understand that maintaining a sprinkler system is mostly about common sense. Keeping the control valve open, not hanging items from the sprinklers, and making sure that the sprinklers do not get painted or obstructed are the most important items. It is also important to know where the control valve is located so that the water can be shut down after sprinkler activation to minimize water damage. The building owner or manager should understand the sprinkler operation and should conduct periodic inspections and tests to make sure that the system is in good working condition. A recommended inspection and testing program includes the following:

(1) Monthly inspection of all valves to ensure that they are open.
(2) Monthly inspection of tanks, if present, to confirm that they are full.
(3) Monthly testing of pumps, if present, to make sure that they operate properly and do not trip circuit breakers when starting.
(4) Testing of all water flow devices, when provided, every 6 months including monitoring service (note that notification of the monitoring service is essential to make sure that the fire department is not called due to testing).
(5) Ongoing visual inspection of all sprinklers to make sure that they are not obstructed and decorations are not attached or hung from them.
(6) Whenever painting or home improvements are made in the dwelling unit, special attention should be paid to ensure that sprinklers are not painted or obstructed either at the time of installation or during subsequent redecoration. When painting is occurring in the vicinity of sprinklers, the sprinklers should be protected by covering them with a bag, which should be removed immediately after painting is finished.

h. What components are needed to install such system and will product suppliers sell the materials such as sprinkler heads and related equipment to homeowners or to only licensed contractors?

FINDING: An automatic sprinkler system consists of valves, pipes and sprinklers with heat sensitive elements. The system is connected to a water supply system such as a city main or water tank. When heat from a fire raises the temperature, it melts a fusible element located in the sprinkler near the fire, thus releasing water. Each sprinkler head operates independently, distributing water only over the area of the fire. The melting temperate of the fusible element (usually 155 degrees Fahrenheit) is referred to as the rating of the sprinkler. Attached you will find information regarding the components of an NFPA 13D system and the product suppliers will sell to homeowners if the law goes into effect.

i. Will the municipalities include this new system as an additional item to financially assess the homeowner on and what are the implications of such annual cost assessment to a homeowner?

FINDING: Approximately 20 towns were contacted in order to determine whether or not they would financially assess the homeowner on an NFPA 13D sprinkler system. Most towns have a computer based appraisal system. Some of these systems have on them "sprinklers within a home" and others do not. The cost between the 12 towns that assess sprinklers within single family dwellings are from $60 to $300 based on the mill rate, wet, dry or a concealed system and the square footage of the home.

j. What are the specific insurance implications to a homeowner?

FINDING: Homeowner policies have coverage for both property (building and contents) and liability (injury to others and negligence). The rate charged and resultant premium paid is a composite of the property exposure and the liability exposure. Three companies provide credits that apply to the composite premium. One company provides a credit on only the property portion of the premium. The two companies using the 13%/8% credits are using the Insurance Services Office (ISO) rates. The third company has individually filed rates. Additional research would be possible by reviewing all insurance company filings at the State Insurance Department.

Connecticut Rate Survey

- Company #1: 13% credit for full protection (NFPA 13)
  8% credit for NFPA 13D system
  No variation of type of water supply
  Applies to base policy premium
  No change in credit between "high value" and standard homes
- Company #2: 10% credit for full protection (NFPA 13)
  6% credit for NFPA 13D system
  Applies to the fire portion of the policy premium
  No change in credit between "high value" and standard homes
- Company #3: 13% credit for full protection (NFPA 13)
  8% credit for NFPA 13D system
  Applies to the total premium
  No change in credit between "high value" and standard homes

The Insurance Services Office (ISO) has published advisory rates to 13% for NFPA 13 systems and 8% for NFPA 13D systems. ISO also develops and provides a community grading (1 through 9) that is an evaluation of local fire department, water supply, communications and code enforcement functions. Many insurance companies use this grading in their rating and premium calculation processes. ISO would "downgrade" a community which has adopted a code with amendments that weaken the code. The ISO fact sheet is attached. It did not copy well because it was in pdf format but the text is readable.

k. What are the financial costs to rebuild a home that experiences a fire with and without a residential sprinkler system here in Connecticut and/or the northeast?
l. What are the impacts on firefighters, first responders as well as residential occupant safety?

FINDING: The committee decided to answer these two questions together based on the information that was obtained dealt with both issues in a consolidated manner.

Newer Homes and Fire

Opponents of residential fire sprinkler systems like to boast that newer homes are safer homes and that the fire and death problem is limited to older homes. Age of housing is a poor predictor of fire death rates. When older housing is associated with higher rates, it usually is because older housing tends to have a disproportionate share of poorer, less educated households. Statistically, the only fire safety issue that is relevant to the age of the home is outdated electrical wiring. Beyond that, age of the home has little to nothing to do with fire safety. In fact, new methods of construction negatively impact occupant and firefighter life safety under fire conditions. The National Research Council of Canada (NRC) tested the performance of unprotected floor assemblies exposed to fire. The findings of the study, *The Performance of Unprotected Floor Assemblies in Basement Fire Scenarios* assert that these structures are prone to catastrophic collapse as early as six minutes from the onset of fire.

In 2008, Underwriters Laboratories (UL) conducted a study to identify the danger to firefighters created by the use of lightweight wood trusses and engineered lumber in residential roof and floor designs. The findings of the report *Structural Stability of Engineered Lumber in Fire Conditions* point to the failure of lightweight engineered wood systems when exposed to fire. Firefighters expecting thirty minutes of structural integrity with dimensional wood structures face higher peril in lightweight structures. The same UL study found that the synthetic construction of today's home furnishings add to the increased risk by providing a greater fuel load. Larger homes, open spaces, increased fuel loads, void spaces and changing building materials contribute to:

- Faster fire propagation
- Shorter time to flashover
- Rapid changes in fire dynamics
- Shorter escape time
- Shorter time to collapse

Lightweight construction has been variously estimated to be used in one half to two thirds of all new wood one and two family homes. Fire sprinklers can offset the increased dangers posed by lightweight construction and create a safer fire environment for firefighters to operate in.

Home Fire Sprinkler Requirements – Impact on Fire Service

Requiring fire sprinklers in new homes helps fire service efforts. Adopting home fire sprinkler requirements have allowed the fire service to keep up with growth and to continue to provide an appropriate level of service which many times translate into savings for a community. Where fires occur in sprinklered buildings, fewer man hours are spent fighting the fire. As such, firefighters are freed up to handle other tasks necessary of the fire department without having to employ additional personnel. Also included in this category are the savings in materials used to fight a fire such as fuel for fire trucks, which are left running during a fire event, and water, which costs the utility money to clean and make available at the hydrant. Fires in buildings with sprinkler systems use thousands of gallons of water less than fires that occur in unsprinklered property.

Residential Sprinklers

Residential fire sprinkler systems are specifically intended to provide a minimum of 10 minutes of egress time to dwelling occupants and therefore are primarily life safety devices. Residential sprinklers are not intended to protect the structure, however, in most real world cases a single sprinkler operates and controls or extinguishes the fire, saving both lives and property. Given the focus on the life safety aspect of residential sprinkler systems, there has been limited research or testing designed to quantify the property protection benefits of these systems. Additionally, the research that has been conducted to quantify the value of residential sprinklers has typically addressed only the building occupants and has not considered additional benefits arising from firefighter safety. It is generally observed that once a fire progresses from its area and material of origin and begins to involve the building structure, it is difficult for offensive manual firefighting operations to successfully intervene. A very common outcome in these cases is total loss of the involved structure.

Real scale tests using sprinklered and unsprinklered structures including typical lightweight, composite wood joist ceiling/floor assemblies were conducted at UL. The tests demonstrated that residential sprinklers operating at flow rates as low as 13 gpm can arrest fire growth rates sufficiently to prevent excessive fire damage and structural collapse. Tests without sprinklers indicate total failure of the structure can occur in under 10 minutes from ignition.

The results from this test series demonstrate that exposed, lightweight composite wood joists are likely to fail three to five minutes after compartment flashover for structures with typical residential loadings. Further, the time to collapse as measured from the start of flaming combustion for the fire scenarios employed in this test series was between 8 and 12 minutes. This relatively small time frame prior to the failure of exposed composite wood joists may require the fire service to adopt alternative tactics and procedures for structures built using lightweight construction methods.

This test program further highlights the dramatic differences between the sprinklered and unsprinklered scenarios, as demonstrated through photographs, observations and data collected. All of the information presented shows that the addition of a sprinkler system can greatly enhance life safety of both residents and firefighters and aid in property protection. Today's homes contain more products with higher heat release rates than in previous years and the construction of these homes has become less fire resistant due to the use of lightweight construction materials. This combination has proven to be deadly for firefighters.

NOTE: The information with regard to "Item k and l" above was taken from an article published by NFPA.

m. Education to understand the requirements of the 2009 International Residential Code, Sections R313 and P2904, to potential user groups such as the construction industry, code officials relative to NFPA 13D.

FINDING: The committee found that training on residential fire sprinkler systems is necessary to educate the affected stakeholders. These stakeholders being members of the fire service, building departments, building developers, architects, fire sprinkler contractors, public/private water suppliers, public health officials and other interested parties throughout Connecticut. Additionally, the committee found that through the Office of Education and Data Management, National Fire Protection Association, International Code Council and the sprinkler industry, this training is readily available.

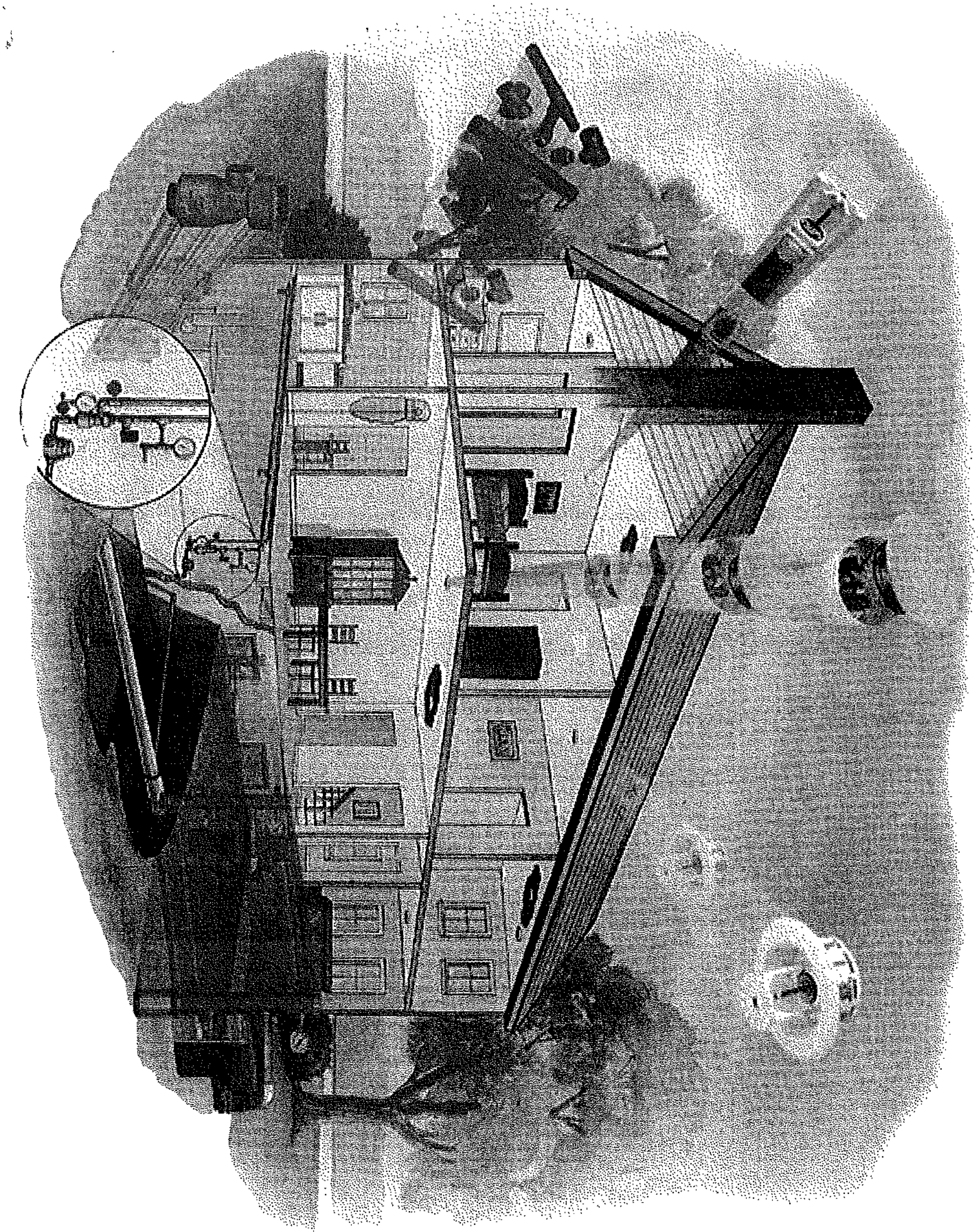
Attachments

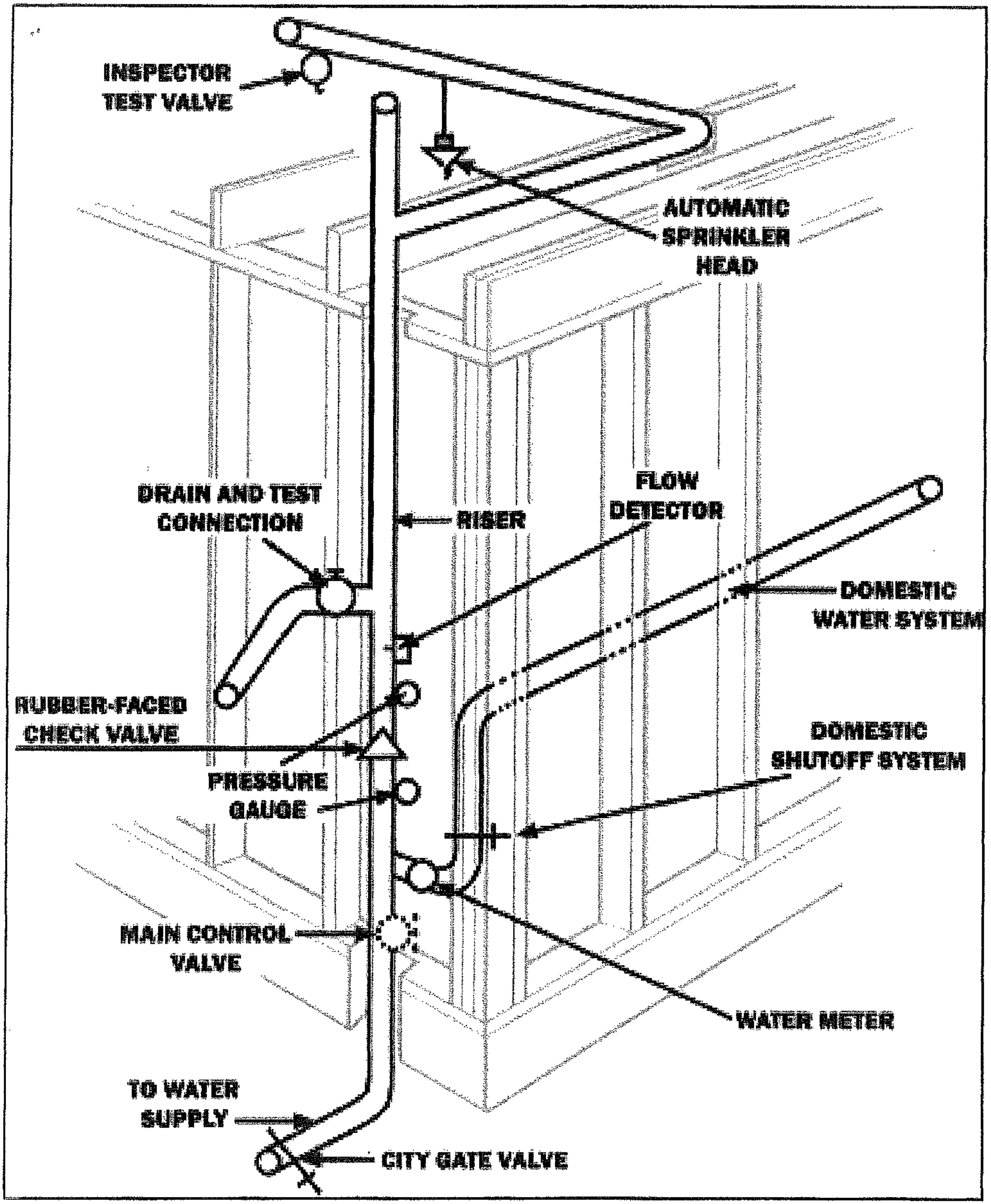
MEMBERS

RESIDENTIAL SPRINKLER COMMITTEE MEMBERS

NAME	REPRESENTING
Appleby, Chuck	CT Plumbers Association
Campion, Brooks	Robinson and Cole
Carozza, Peter	President, Uniformed Professional Fire Fighter of CT
Crombie, Phillip Jr.	Insurance Industry
DiPace, Jamie	CT Fire Chiefs
Doyle, John	American Institute of Architects, CT Chapter
Duval, Robert	National Fire Protection Association
Ellrod, Earl III	American Society of Plumbing Engineers, CT Chapter
Finn, Brian	Local 669 Sprinkler Fitters Union
Fusari, Robert Sr.	CT Home Builders Association
Huber, J. Whitney	AIA-American Institute of Architects
Hurlburt, Richard M.	CT Dept. of Consumer Protection-Occupational & Professional Licensing Division
Keefe, Jack	
Keith, Gary	NFPA
Kingston, Joe Co-Chairman	**DCS-Office of State Fire Marshal**
Kasmauskas, Dominick	National Fire Sprinkler Association
Jansen, Jack	American Fire Sprinkler Association, CT Chapter
Lagocki, Alan	AIA-American Institute of Architects, CT Chapter
Livingstone, John	Local 669 Sprinkler Fitters Union
McCarthy, Dennis	CT Career Fire Chief's Association
Michelson, John	
Paige, Todd	CT Career Fire Chief's Association
Pellecchia, Joe	CT Plumbing, Heating and Cooling Construction Association
Rapanault, Paul	Uniformed Professional Fire Fighter of CT
Richards, Ken	CT Fire Chiefs Association
Ross, Rob, Chairman	**DESPP-DFEBS**
Thompson, Dave	American Builders & Contractors, CT Chapter
Tierney, Dan Co-Chairman	**DCS-Office of State Building Inspector**
Tourville, Patrick	President & Representative, CT Fire Marshals Association
Travers, Tim	National Fire Protection Association
Viola, Jack	American Fire Sprinkler Association, CT Chapter
Walker, Raymond Jr.	CT Conference of Municipalities
York, Timothy	President, CT Building Officials Association
Waskowicz, Dave	Industry Rep.

ATTACHMENTS




INSPECTOR TEST VALVE
AUTOMATIC SPRINKLER HEAD
DRAIN AND TEST CONNECTION
RISER
FLOW DETECTOR
DOMESTIC WATER SYSTEM
RUBBER-FACED CHECK VALVE
DOMESTIC SHUTOFF SYSTEM
PRESSURE GAUGE
MAIN CONTROL VALVE
WATER METER
TO WATER SUPPLY
CITY GATE VALVE

Contact Information:
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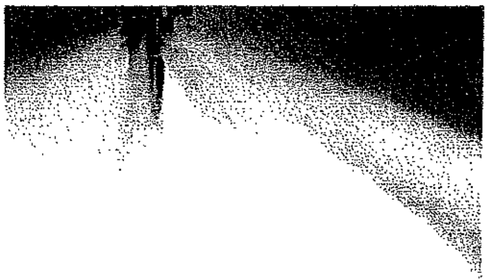
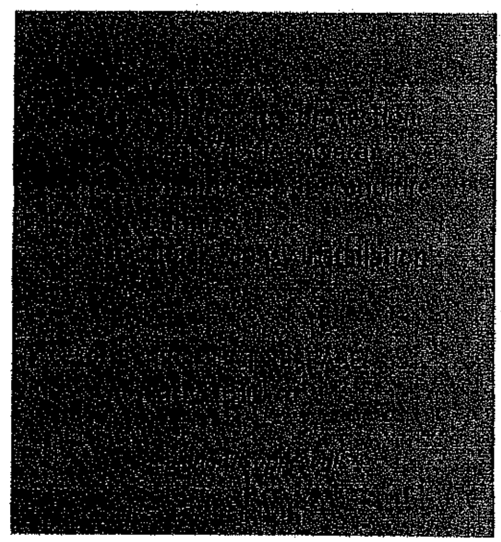
UTC Fire & Security
A United Technologies Company

HI-FOG® Water Mist - A Fire Protection System For The Home



UTC Fire & Security is developing a fire protection system for the home based on the world's leading commercial water mist technology; Marioff HI-FOG®, which is installed in prestigious buildings such as the National Gallery of Art, Hearst Castle, The Nobel Peace Center and Marriott Hotels around the world.

The HI-FOG Water Mist Fire Protection System is the most modern and effective fire protection technology for your home.



What is Water Mist?

HI-FOG® water mist system is composed of tiny micro-droplets that represent water in its most efficient fire-fighting form. When a HI-FOG® system activates, it instantly attacks the fire by discharging high –velocity water mist that penetrates the fire plume and controls the fire. The space cools as it quickly fills with mist. The micro-droplets block and scatter the fire's radiant heat. Using 80% less water the fire is suppressed before it can spread and do serious harm.

Why Water Mist?

Water mist provides superior fire protection by suppressing the fire, cooling the surrounding area and providing a safe pathway out of the home. Water mist uses dramatically less water, which allows the water and fire damage to be kept to a minimum. It resolves many concerns homeowners may have related to water issues such as water meter connections and fees, well water and water sustainability.

Easy Installation

The water mist system uses small flexible hose that is quick to install and easy to maneuver around unique angles, corners and architectural obstructions. The system is small enough to be hidden from view by using a variety of design elements such as crown molding to preserve the home aesthetics. The system requires minimal joints and as a result greatly reduces the risk of leaks.

About UTC Fire & Security

UTC Fire & Security provides fire safety and security solutions to more than 1 million customers worldwide. Headquartered in Conn, U.S., UTC Fire & Security is a business unit of United Technologies Corp., which provides high technology products and services to the building and aerospace industries worldwide. UTC offers well-known residential consumer brands such as Carrier air conditioning and heating systems and Kidde fire safety and protection solutions. More information about UTC Fire & Security can be found at http://www.utcfireandsecurity.com

HI-FOG®
water mist fire protection

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 NFPA 13D is appropriate for protection against fire hazards only in one- and two-family dwellings and manufactured homes. Residential portions of any other type of building or occupancy should be protected with residential sprinklers in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, or in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.* Other portions of such buildings should be protected in accordance with NFPA 13 or NFPA 13R as appropriate for areas outside the dwelling unit.

The criteria in this standard are based on full-scale fire tests of rooms containing typical furnishings found in residential living rooms, kitchens, and bedrooms. The furnishings were arranged as typically found in dwelling units in a manner similar to that shown in Figure A.1.1(a), Figure A.1.1(b), and Figure A.1.1(c). Sixty full-scale fire tests were conducted in a two-story dwelling in Los Angeles, California, and 16 tests were conducted in a 14 ft (4.3 m) wide mobile home in Charlotte, North Carolina.

Sprinkler systems designed and installed according to this standard are expected to prevent flashover within the compartment of origin where sprinklers are installed in the compartment. A sprinkler system designed and installed according to this standard cannot, however, be expected to completely control a fire involving fuel loads that are significantly higher than average for dwelling units [10 lb/ft^2 (49 kg/m^2)] and where the interior finish has an unusually high flame spread index (greater than 225) when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials.*

(For protection of multifamily dwellings, see NFPA 13 or NFPA 13R.)

A.1.2 While the purpose of this standard is to provide improved protection against injury and loss of life, the use of these systems has demonstrated an ability to provide improved protection against property damage. Various levels of fire safety are available to dwelling occupants to provide life safety and property protection.

This standard recommends, but does not require, sprinklering of all areas in a dwelling; it permits sprinklers to be omitted in certain areas. These areas have been proved by NFPA statistics *[see Table A.1.2(a) and Table A.1.2(b)]* to be those where the incidence of life loss from fires in dwellings is low. Such an approach provides a reasonable degree of fire safety. Greater protection to both life and property is achieved by sprinklering all areas.

Guidance for the installation of smoke detectors and fire detection systems is found in *NFPA 72, National Fire Alarm and Signaling Code.*

A.1.5.1 For additional conversions and information, see IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System.*

A.1.5.4 A given equivalent value is considered to be approximate.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate

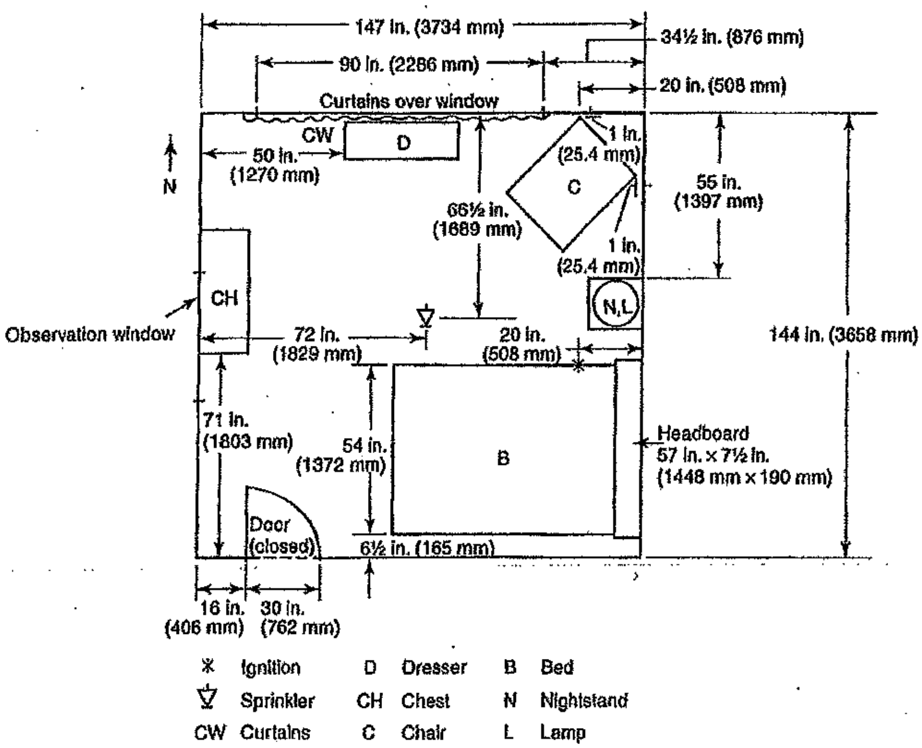


FIGURE A.1.1(a) Bedroom.

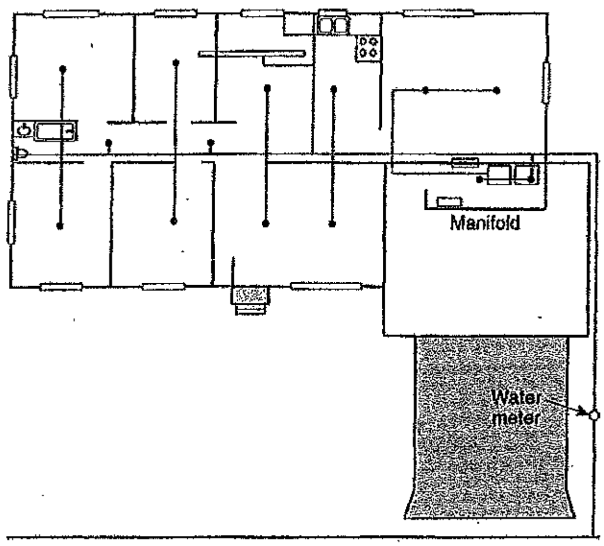


FIGURE A.3.3.9.3(a) Multipurpose Piping System — Example 1.

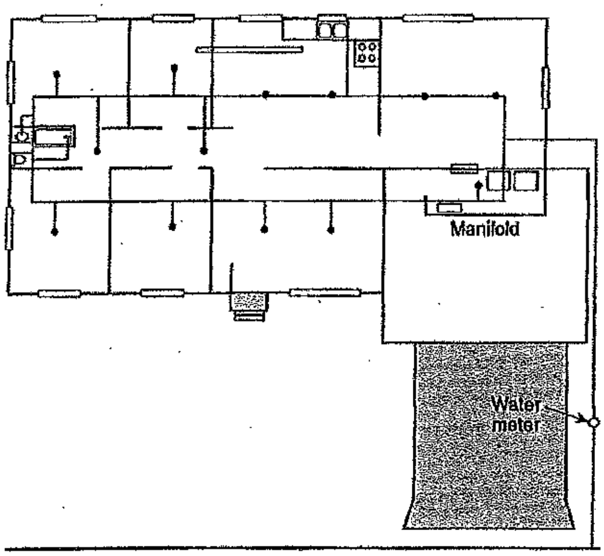


FIGURE A.3.3.9.3(b) Multipurpose Piping System — Example 2.

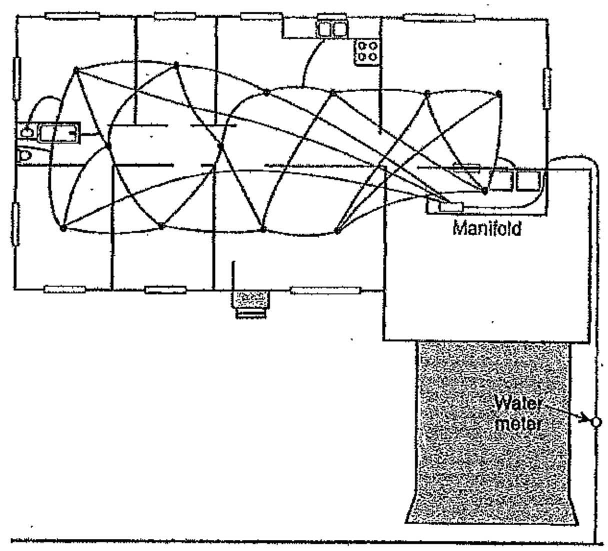


FIGURE A.3.3.9.3(c) Multipurpose Piping System — Example 3 (Network System).

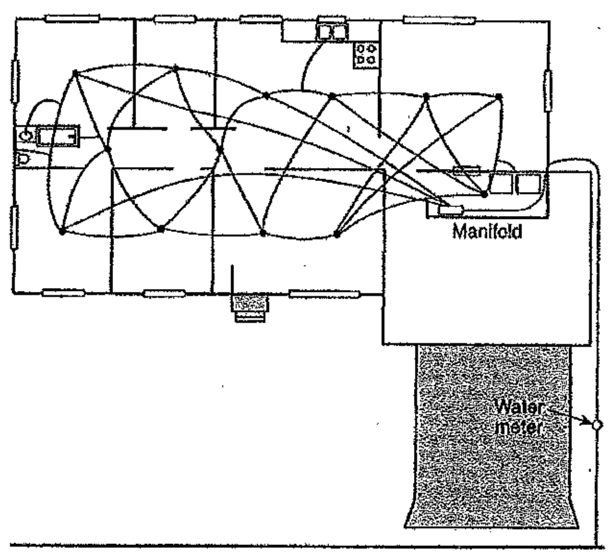


FIGURE A.3.3.9.4 Network System.

(5) Interior walls
(6) Model, manufacturer, temperature, orifice size, and spacing requirements of sprinklers
(7) Type of pipe
(8) Hanger spacing requirement per the pipe manufacturer
(9) Riser detail
(10) Installing contractor information
(11) Preliminary hydraulic calculations

A.5.1.1 Where fused sprinklers are replaced by the owner, fire department, or others, care should be taken to ensure that the replacement sprinkler has the same operating characteristics.

A.5.2.1 For reference the information in Table A.5.2.1(a) through Table A.5.2.1(d) is provided to assist in the determination of acceptable water availability.

A.5.2.2.2 Not all pipe or tube made to ASTM F 442, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, as described in 5.2.2.2 is listed for fire sprinkler service. Listed pipe is identified by the logo of the listing agency.

All nonmetallic pipe and fitting materials can be damaged by contact with chemicals found in some construction products, such as thread sealants, leak detectors, firestops, insulation, spray foams, cutting oils, termiticides, insecticides, antifreeze, coupling lubes, communication cables, wires, flux,

Table A.5.2.1(a) SDR 13.5 IPS Pipe (CPVC)

Nominal Pipe Size (in.)	Average Outside Diameter (in.)	Average Inside Diameter (in.)
¾	1.05	0.87
1	1.32	1.10
1¼	1.66	1.39
1½	1.90	1.60
2	2.38	2.00
2½	2.88	2.42
3	3.50	2.95

Table A.5.2.1(b) SDR 9 CTS Pipe (PEX)

Nominal Diameter (in.)	Outside Diameter		Wall		Inside Diameter	
	in.[*]	mm	in.[†]	mm	in.	mm
⅜	0.50	12.7	0.07	1.8	0.36	9.1
½	0.63	15.9	0.07	1.8	0.49	12.3
¾	0.88	22.2	0.10	2.5	0.68	17.2
1	1.30	28.6	0.13	3.2	0.88	22.2
1¼	1.38	34.9	0.15	3.9	1.07	27.2
1½	1.63	41.2	0.18	4.6	1.26	32.1
2	2.13	54.0	0.24	6.0	1.65	42.0

[*] Average dimensions from ASTM F 876.
[†] Minimum wall thickness from ASTM F 876.

solder, mastic, PVC coated floor clamps, pipe tapes, grease and cooking oils, rubber and plasticizers, antimicrobial coatings, and so forth. The chemical compatibility of such products with the particular pipe or fitting material must be verified prior to use. Otherwise, contact between the construction product and the pipe or fitting must be avoided.

A.5.2.4 Compatible thread sealant or Teflon tape can be used in a CPVC sprinkler head adapter. The combination of the two cannot be used together. The manufacturer of the sprinkler head adapter installation instructions must be followed for each sprinkler head adapter used.

A.5.2.9.2 Not all fittings made to ASTM F 437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*; ASTM F 438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*; and ASTM F 439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, as described in 5.2.9.2 are listed for fire sprinkler service. Listed fittings are identified by the logo of the listing agency.

A.5.3 It is not the intent of NFPA 13D to require the use of NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, for any supply piping.

A.6.2 The connection to city mains for fire protection is often subject to local regulation of metering and backflow prevention requirements. Preferred and acceptable water supply arrangements are shown in Figure A.6.2(a), Figure A.6.2(b), and Figure A.6.2(c). Where it is necessary to use a meter between the city water main and the sprinkler system supply, an acceptable arrangement as shown in Figure A.6.2(c) can be used. Under these circumstances, the flow characteristics of the meter are to be included in the hydraulic calculation of the system [*see Table 8.4.4(g)*]. Where a tank is used for both domestic and fire protection purposes, a low water alarm that actuates when the water level falls below 110 percent of the minimum quantity specified in 6.1.2 should be provided.

The effect of pressure-reducing valves on the system should be considered in the hydraulic calculation procedures.

Table A.5.2.1(c) Steel Pipe Dimensions

Nominal Pipe Size		Outside Diameter		Schedule 5 Inside Diameter		Schedule 5 Wall Thickness		Schedule 10[a] Inside Diameter		Schedule 10[a] Wall Thickness		Schedule 30 Inside Diameter		Schedule 30 Wall Thickness		Schedule 40 Inside Diameter		Schedule 40 Wall Thickness	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
½[b]	15	0.84	21.3	—	—	—	—	0.67	17.0	0.08	2.1	—	—	—	—	0.62	15.8	0.11	2.8
¾[b]	20	1.05	26.7	—	—	—	—	0.88	22.4	0.08	2.1	—	—	—	—	0.82	21.0	0.11	2.9
1	25	1.32	33.4	1.19	30.1	0.07	1.7	1.10	27.9	0.11	2.8	—	—	—	—	1.05	26.6	0.13	3.4
1¼	32	1.66	42.2	1.53	38.9	0.07	1.7	1.44	36.6	0.11	2.8	—	—	—	—	1.38	35.1	0.14	3.6
1½	40	1.90	48.3	1.77	45.0	0.07	1.7	1.68	42.7	0.11	2.8	—	—	—	—	1.61	40.9	0.15	3.7
2	50	2.38	60.3	2.25	57.0	0.07	1.7	2.16	54.8	0.11	2.8	—	—	—	—	2.07	52.5	0.15	3.9
2½	65	2.88	73.0	2.71	68.8	0.08	2.1	2.64	66.9	0.12	3.0	—	—	—	—	2.47	62.7	0.20	5.2
3	80	3.50	88.9	3.33	84.7	0.08	2.1	3.26	82.8	0.12	3.0	—	—	—	—	3.07	77.9	0.22	5.5

[a] Schedule 10 defined to 5 in. (127 mm) nominal pipe size by ASTM A 135, *Standard Specifications for Electric-Resistance-Welded Steel Pipe.*
[b] These values applicable when used in conjunction with 8.15.19.3 and 8.15.19.4 of NFPA 13.
[13: Table A.6.3.2]

Table A.5.2.1(d) Copper Tube Dimensions

Nominal Tube Size		Outside Diameter		Type K Inside Diameter		Type K Wall Thickness		Type L Inside Diameter		Type L Wall Thickness		Type M Inside Diameter		Type M Wall Thickness	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
¾	20	0.88	22.2	0.75	18.9	0.07	1.7	0.79	19.9	0.05	1.1	0.81	20.6	0.03	0.8
1	25	1.13	28.6	1.00	25.3	0.07	1.7	1.03	26.0	0.05	1.3	1.06	26.8	0.04	0.9
1¼	32	1.38	34.9	1.25	31.6	0.07	1.7	1.27	32.1	0.06	1.4	1.29	32.8	0.04	1.1
1½	40	1.63	41.3	1.48	37.6	0.07	1.8	1.51	38.2	0.06	1.5	1.53	38.8	0.05	1.2
2	50	2.13	54.0	1.96	49.8	0.08	2.1	1.99	50.4	0.07	1.8	2.01	51.0	0.06	1.5
2½	65	2.63	66.7	2.44	61.8	0.10	2.4	2.47	62.6	0.08	2.0	2.50	63.4	0.07	1.7
3	80	3.13	79.4	2.91	73.8	0.11	2.8	2.95	74.8	0.09	2.3	2.98	75.7	0.07	1.8

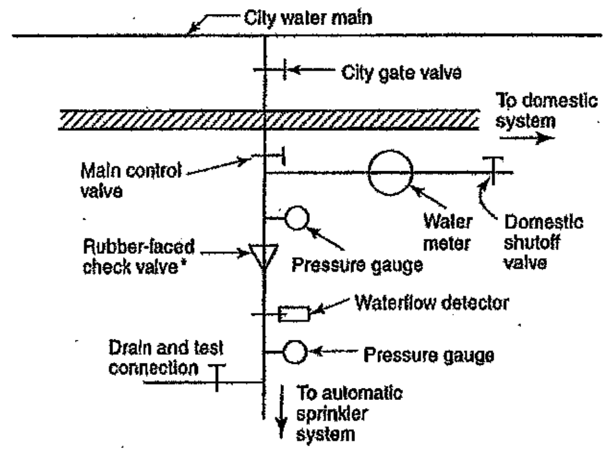
[13: Table: A.6.3.5]

Figure A.6.2(a) is the preferred method for getting the water supply into the unit for a stand-alone sprinkler system (one that does not also provide direct connections to the cold water fixtures) because the common supply pipe for the domestic system and the sprinkler system between the water supply and the dwelling unit has a single control valve that shuts the sprinkler system, which helps to ensure that people who have running water to their domestic fixtures also have fire protection. This serves as a form of supervision for the control valve and can be used to make sure that the valve stays open in place of other, more expensive options such as tamper switches with a monitoring service.

Some water utilities insist on separate taps and supply pipes from the water supply to the dwelling unit for fire sprinkler systems as shown in Figure A.6.2(b), due to concerns about shutting off the water supply for nonpayment of bills and the desire not to shut off fire protection if this ever occurs. While this type of arrangement is acceptable, it is not cost efficient and should be discouraged due to the extra cost burden this places on the building owner. The concern over shutting off the water for nonpayment of bills is a nonissue for a number of reasons. First, the water utilities rarely actually shut off water for nonpayment. Second, if they do shut off water for nonpayment, they are creating violations of all sorts of health and safety codes, allowing people to live in a home without running water. Concern over the fire protection for those individuals when they are violating all kinds of other health codes is disingenuous. More likely, the water utility will not shut off the water and will follow other legal avenues to collect on unpaid bills such as liens on property. Millions of people should not have to pay hundreds of millions of dollars to install separate water taps and lines for the few services that might get shut off.

A.6.2.1 The flow of water is necessary to make sure that the pump does not get damaged during testing. Use of a timer to keep the pump running is not recommended because the timer will allow the pump to run when no water is flowing. The pump needs to run for the entire duration without interruption, including not tripping the circuit breaker.

A.6.2.3 The best method for getting the water supply into the unit for a stand-alone sprinkler system (one that does not also provide direct connections to the cold water fixtures) is to have a common pipe for the domestic system and the sprinkler system between the water supply and the dwelling unit.



* Rubber face optional.

FIGURE A.6.2(a) Preferable Arrangement for Stand-Alone Piping Systems.

Once inside the dwelling unit, the pipes can be split to provide the individual domestic and sprinkler systems. In this arrangement, a single control valve on the combined pipe (prior to the split) as shown in Figure A.6.2(a) being the only control valve that shuts the sprinkler system is preferred because it ensures that people who have running water to their domestic fixtures also have fire protection. This serves as a form of supervision for the control valve and can be used to make sure that the valve stays open in place of other, more expensive options such as tamper switches with monitoring service.

Some water utilities insist on separate taps and supply pipes from the water supply to the dwelling unit for fire sprinkler systems due to concerns about shutting off the water supply for nonpayment of bills and the desire not to shut off fire protection if this ever occurs. While this type of arrangement is acceptable [see Figure A.6.2(b)], it is not cost efficient and should be discouraged due to the extra burden this places on the building owner. The concern over shutting off the water for nonpayment of bills is a nonissue for a number of reasons. First the water utilities rarely actually shut off water for nonpayment. Second, if they do shut off water for nonpayment, they are creating violations of all sorts of health and safety

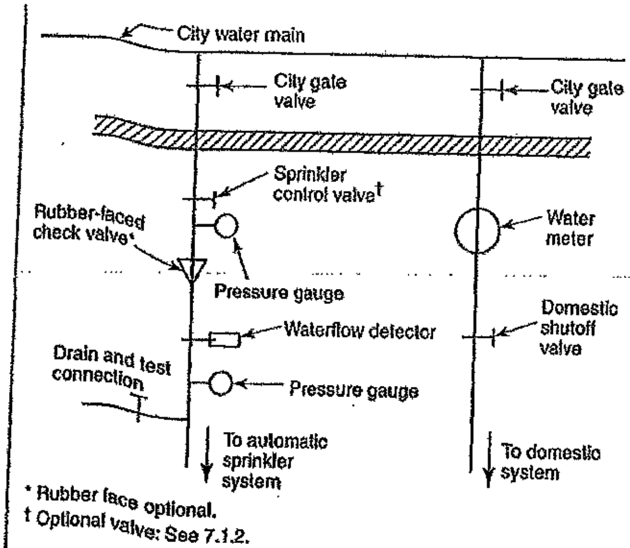


FIGURE A.6.2(b) Acceptable Arrangement for Stand-Alone Piping Systems with Valve Supervision — Option 1.

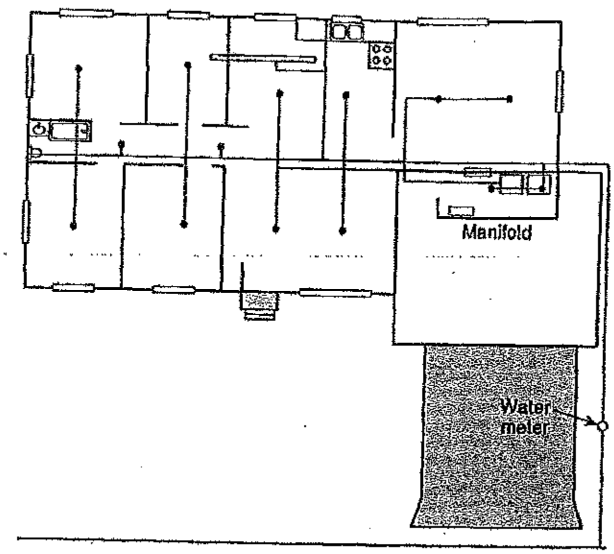


FIGURE A.6.3(a) Multipurpose Piping System — Example 1.

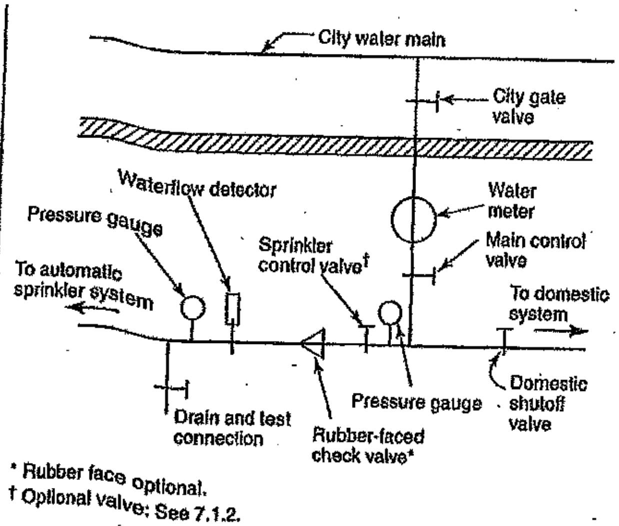


FIGURE A.6.2(c) Acceptable Arrangement for Stand-Alone Piping Systems with Valve Supervision — Option 2.

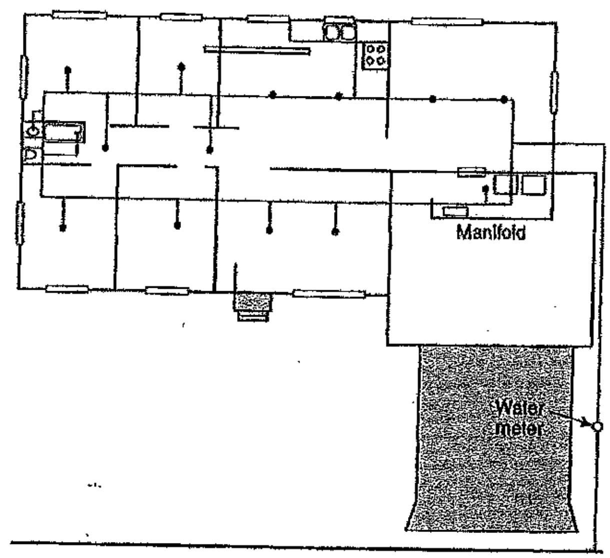


FIGURE A.6.3(b) Multipurpose Piping System — Example 2.

codes, allowing people to live in a home without running water. Concern over the fire protection for those individuals when they are violating all kinds of other health codes is disingenuous. More likely, the water utility will not shut off the water and will follow other legal avenues to collect on unpaid bills such as liens on property. Millions of people should not have to pay hundreds of millions of dollars to install separate water taps and lines for the few services that might get shut off.

A.6.3 Multipurpose piping systems consist of a single piping system within a residential occupancy that is intended to serve both domestic and fire protection needs. Basic forms of this system are shown in Figure A.6.3(a), Figure A.6.3(b), Figure A.6.3(c), and Figure A.6.3(d). A network system, as defined in 3.3.9.4, is a type of multipurpose system that utilizes a common piping system supplying domestic fixtures and fire sprinklers where each sprinkler is supplied by a minimum of three separate paths. In dwellings where long-term use of lawn sprinklers is common, provision should be made for such usage.

A.7.2.4 These connections should be installed so that the valve can be opened fully and for a sufficient time period to ensure a proper test without causing water damage. The test connection should be designed and sized to verify the sufficiency of the water supply and alarm mechanisms.

A.7.4.4 The reaction forces caused by the flow of water through the sprinkler could result in displacement of the sprinkler, thereby adversely affecting sprinkler discharge.

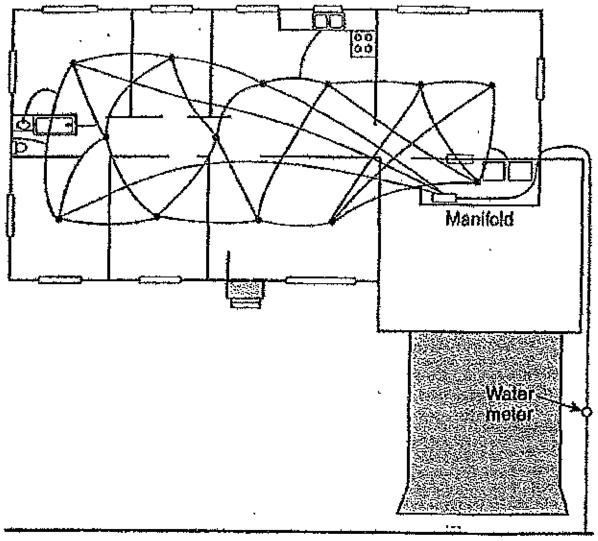


FIGURE A.6.3(c) Multipurpose Piping System — Example 3 (Network System).

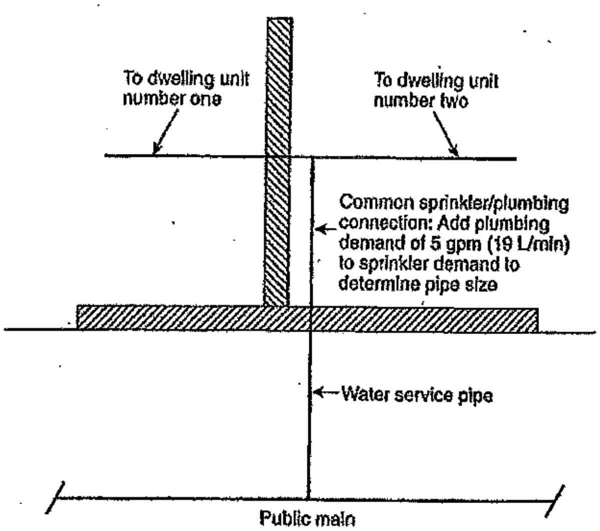


FIGURE A.6.3(d) Common Water Supply Connection Serving More Than One Dwelling Unit.

A.7.5.5.3 Care should be taken in positioning sprinklers in bathrooms near exhaust fan units. Some exhaust fan units have heaters built in to warm up the bathroom, and these units have the potential to activate sprinklers. Combination exhaust fan and heater units should be treated as wall-mounted diffusers for the purposes of using Table 7.5.5.3.

A.7.5.6 Decorative painting of a residential sprinkler is not to be confused with the temperature identification colors as specified in 6.2.5 of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

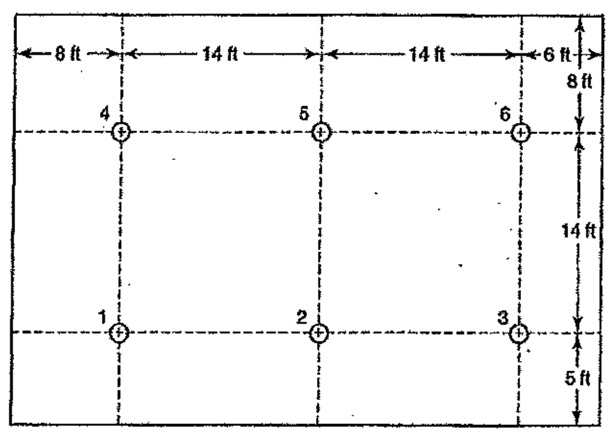
A.7.6 The local waterflow alarm is intended to be a single alarm audible from the outside of the building. It can be mounted on the outside of the home or within the building close to the outside. This should not limit its use to prevent interior or remote notification. Interconnection with a smoke alarm or remote monitoring might improve notification, but is considered too costly to mandate for every system installed in accordance with this standard. It is not the intent of this standard to require central station monitoring or a fire alarm system.

An exterior alarm can be of benefit in areas where a neighbor could alert the fire department or to enhance the ability for an assisted rescue by a passerby.

A waterflow test is normally conducted using the system drain. Figure A.6.2(a), Figure A.6.2(b), and Figure A.6.2(c) show examples of this arrangement.

A.8.1.1.2 The minimum pressure and flow requirements need to be satisfied while also meeting the requirements of the formula $q = K(p)^{0.5}$. If a sprinkler with a K-factor of 4.3 is listed to cover an area of 18 ft × 18 ft (5.5 m × 5.5 m) at 16.2 gpm (61.3 L/min), the minimum pressure is required to be 14.2 psi (0.98 bar) so that the flow is achieved. Likewise, if a sprinkler with a K-factor of 5.6 is covering an area 12 ft × 12 ft (3.66 m × 3.66 m), the minimum flow is required to be 14.8 gpm (56 L/min) [the flow at 7 psi (0.48 bar)] even though a flow of 7.2 gpm (27.3 L/min) will satisfy the density criteria.

A.8.1.1.2.2 Sprinklers need to be used in accordance with their listed areas and density. *(See Figure A.8.1.1.2.2.)*



Sprinkler 1, 4, 5, 6 — 16 ft × 16 ft coverage used to determine flow
Sprinkler 2, 3 — 14 ft × 14 ft coverage used to determine flow

FIGURE A.8.1.1.2.2 Determining Required Flow.

A.8.1.2 All residential sprinklers have been investigated and are currently listed for use under flat, smooth, horizontal ceilings. Some residential sprinklers have been investigated and listed for use under specific smooth sloped or horizontal beamed ceilings. Where ceilings have configurations outside the scope of current listings, special sprinkler system design features such as larger flows, a design of three or more sprinklers to operate in a compartment, or both can be required. Figure A.8.1.2(a) and Figure A.8.1.2(b) show examples of design configurations.

Questions are frequently asked regarding the minimum two sprinkler design when certain sprinkler performance statistics have indicated that in a majority of the cases (with residential sprinklers) the fire is controlled or suppressed with a single sprinkler. While these statistics may or may not be correct, the water

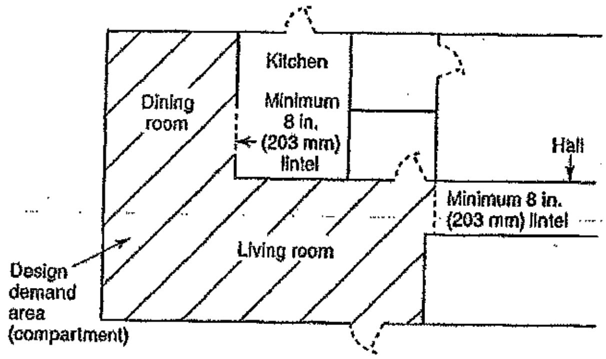


FIGURE A.8.1.2(a) Sprinkler Design Areas for Typical Residential Occupancy — Without Lintel.

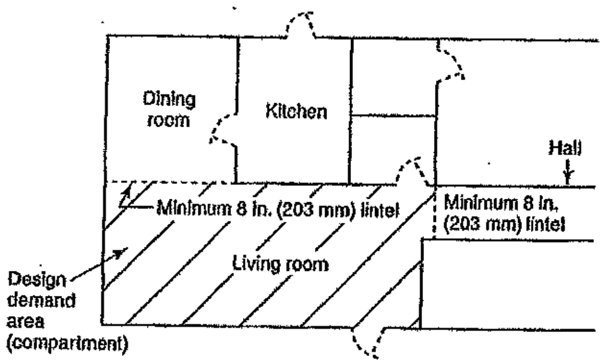


FIGURE A.8.1.2(b) Sprinkler Design Areas for Typical Residential Occupancy — With Lintel.

supplies for the fire sprinkler systems under which these statistics were generated were designed for two or more sprinklers in the first place. When the fires occurred, the first sprinkler operated in excess of its individual design flow and pressure because the sprinkler system's water supply was strong enough to handle multiple sprinklers and only a single sprinkler opened. At these higher flows and pressures, the discharge from a single sprinkler was sufficient to limit or suppress the heat generated from the fire. This concept is called "hydraulic increase." Hydraulic increase can also occur when a water supply's capabilities during the fire event exceeded that required by the minimum design requirements of the standard. Since none of the data used to generate the previously mentioned statistics captured the capabilities of the water supply in relation to the design requirements, the impact of the hydraulic increase on the number of single sprinkler activations cannot be determined.

But if the minimum water supply requirement of the standard is reduced to only be capable of handling a single sprinkler, then there could be no hydraulic increase safety factor. When the first sprinkler opens, it will only get the flow and pressure that were originally designed for it, and the potential is significant for that to be insufficient to control the fire given any obstructions and the layout of the space where the fire starts.

The National Institute for Standards and Technology (NIST), under a grant from the United States Fire Administration, studied this concept several years ago in the hopes of being able to propose a single sprinkler flow for the 2007 edition of NFPA 13D (see NIST Report NIST GCR 05-875 prepared by Underwriters Laboratories with a publication date of February 2004). Unfortunately, the research did not support the design of a sprinkler system with only the flow for a single sprinkler, even under conditions of small rooms with flat, smooth ceilings. Without the hydraulic increase associated with the two sprinkler design, the fire scenarios were too many where the first sprinkler to open would have insufficient flow to control the fire and then multiple sprinklers would open, causing the room to reach untenable conditions and the water supply to be overrun. These same fire scenarios were easily controlled by a sprinkler system designed for a two sprinkler water supply from the start.

In addition to the NIST tests, the National Fire Sprinkler Association conducted a series of full-scale fire tests in simulated bedrooms that were 14 ft × 14 ft with an adjoining hallway, each with flat, smooth, 8 ft high ceilings. The tests were performed to determine better rules for keeping sprinklers clear of obstructions like ceiling fans, but baseline tests were also performed without any obstructions at the ceiling. In nine out of the twelve tests, including the two baseline tests without obstructions at the ceiling, a sprinkler in the hall outside the room of fire origin opened first, followed by the sprinkler in the room of origin. Even though the room of origin met all of the rules of NFPA 13D as a compartment, a sprinkler outside of this room was opening first. All of these fires were controlled by the sprinklers, but if the water supply had only been sufficient for a single sprinkler, the sprinklers would never have been able to provide fire control.

A.8.1.3.1.2 Construction features such as large horizontal beamed ceilings, sloped ceilings having beams, and steeply sloped ceilings are outside of the current listings. In these situations, sprinklers can be installed in a manner acceptable to the authority having jurisdiction to achieve the results specified in this standard. In making these determinations, consideration should be given to factors influencing sprinkler system performance, such as sprinkler response characteristics, impact of obstructions on sprinkler discharge, and number of sprinklers anticipated to operate in the event of a fire.

A.8.2.5 The objective is to position sprinklers so that the response time and discharge are not unduly affected by obstructions such as ceiling slope, beams, light fixtures, or ceiling fans. The rules in this section, while different from the obstruction rules of NFPA 13, *Standard for the Installation of Sprinkler Systems*, provide a reasonable level of life safety while maintaining the philosophy of keeping NFPA 13D relatively simple to apply and enforce.

Fire testing has indicated the need to wet walls in the area protected by residential sprinklers at a level closer to the ceiling than that accomplished by standard sprinkler distribution. Where beams, light fixtures, sloped ceilings, and other obstructions occur, additional residential sprinklers are necessary to achieve proper response and distribution. In addition, for sloped ceilings, higher flow rates could be needed. Guidance should be obtained from the manufacturer.

A series of 33 full-scale tests were conducted in a test room with a floor area of 12 ft × 24 ft (3.6 m × 7.2 m) to determine the effect of cathedral (sloped) and beamed ceiling construction, and combinations of both, on fast-response residential sprinkler performance. The testing was performed using one pendent-type residential sprinkler model, two ceiling slopes (0 degrees and 14 degrees), and two beam configurations on a single enclosure size. In order to judge the effectiveness of sprinklers in controlling fires, two baseline tests, in which the ceiling was smooth and horizontal, were conducted with the pendent sprinklers installed and with a total water supply of 26 gpm (98 L/min) as required by this standard. The results of the baseline tests were compared with tests in which the ceiling was beamed or sloped, or both, and two pendent sprinklers were installed with the same water supply. Under the limited conditions used for testing, the comparison indicates that sloped or beamed ceilings, or a combination of both, represent a serious challenge to the fire protection afforded by fast-response residential sprinklers. However, further tests with beamed ceilings indicated that fire control equivalent to that obtained in the baseline tests can be obtained where one sprinkler is centered in each bay formed by the beams and a total water supply of 36 gpm (136 L/min) is available. Fire control equivalent to that obtained in the baseline tests was obtained for the smooth, sloped ceiling tests where three sprinklers were installed with a total water supply of 54 gpm (200 L/min). In a single smoldering-started fire test, the fire was suppressed.

Small areas created by architectural features such as planter box windows, bay windows, and similar features can be evaluated as follows:

(1) Where no additional floor area is created by the architectural feature, no additional sprinkler protection is required.
(2) Where additional floor area is created by an architectural feature, no additional sprinkler protection is required, provided all of the following conditions are met:
   (a) The floor area does not exceed 18 ft^2 (1.7 m^2).
   (b) The floor area is not greater than 2 ft (0.65 m) in depth at the deepest point of the architectural feature to the plane of the primary wall where measured along the finished floor.
   (c) The floor area is not greater than 9 ft (2.9 m) in length where measured along the plane of the primary wall.

Measurement from the deepest point of the architectural feature to the sprinkler should not exceed the maximum listed spacing of the sprinkler. The hydraulic design is not required to consider the area created by the architectural feature.

Where the obstruction criteria established by this standard are followed, sprinkler spray patterns will not necessarily get water to every square foot of space within a room. As such, a sprinkler in a room with acceptable obstructions as outlined in this standard might not be capable of passing the fire test (specified by ANSI/UL 1626, *Residential Sprinklers for Fire-Protection Service*, and other similar laboratory standards) if the fire is started in one of these dry areas. This occurrence is not to be interpreted as a failure of the sprinkler. The laboratory fire tests are sufficiently challenging to the sprinkler without additional obstructions as a safety factor to account for the variables that actually occur in dwellings, including acceptable obstructions to spray patterns.

The rules on 8.2.5.2 and 8.2.5.3 were developed from a testing series conducted by the National Fire Sprinkler Association and The Viking Corporation that included fire modeling, sprinkler response tests, sprinkler distribution tests, and full-scale fire tests (Valentine and Isman, *Interaction of Residential Sprinklers, Ceiling Fans and Similar Obstructions*, National Fire Sprinkler Association, November 2005). This test series, along with additional industry experience, shows that a difference exists between obstructions that are tight to the ceiling and obstructions that hang down from the ceiling, allowing spray over the top. Residential sprinklers require high wall wetting, which means that they tend to spray over obstructions that hang down from the ceiling. The test series showed that the fan blades were not significant obstructions and that as long as the sprinkler was far enough from the fan motor housing (measured from the center of the housing), the sprinkler could control a fire on the other side of the fan in a small room. In larger rooms, the sprinkler will need to be augmented by additional sprinklers on the other side of the fan. The test series showed that the fan on low or medium speed did not make a significant difference in sprinkler performance. On high speed (pushing air down), the fan did impact sprinkler performance, but fire control was still achieved in small rooms. In larger rooms, it is expected that additional sprinklers would be installed. The test series also showed that the fan blowing down was more significant than the fan pulling air up.

The rules in 8.2.5.6 were developed from years of experience with obstruction rules and an additional test series conducted by the National Fire Sprinkler Association with the help of Tyco International (Valentine and Isman, *Kitchen Cabinets and Residential Sprinklers*, National Fire Sprinkler Association, November 2005), which included fire modeling, distribution tests, and full-scale fire tests. The test series showed that pendent sprinklers definitely provide protection for kitchens, even for fires that start under the cabinets. The information in the series was less than definitive for sidewall sprinklers, but distribution data show that sprinklers in the positions in this standard provide adequate water distribution in front of the cabinets and that sidewall sprinklers should be able to control a fire that starts under the cabinets. When protecting kitchens or similar rooms with cabinets, the pendent sprinkler should be the first option. If pendent sprinklers cannot be installed, the next best option is a sidewall sprinkler on the opposite wall from the cabinets, spraying in the direction of the cabinets. The third best option is the sidewall sprinkler on the same wall as the cabinets on a soffit flush with the face of the cabinet. The last option should be putting sprinklers on the wall back behind the face of the cabinet because this location is subject to being blocked by items placed on top of the cabinets. It is not the intent of the committee to require sprinklers to be installed under kitchen cabinets.

A.8.3.1 In areas subject to freezing, care should be taken in unheated attic spaces to cover sprinkler piping completely with insulation. Installation should follow the guidelines of the insulation manufacturer. Figure A.8.3.1(a) through Figure A.8.3.1(e) show several methods that can be considered.

A.8.3.3.1 Antifreeze solutions can be used for maintaining automatic sprinkler protection in small, unheated areas. Antifreeze solutions are recommended only for systems not exceeding 40 gal (151 L).

Because of the cost of refilling the system or replenishing small leaks, small, dry valves should be used where more than 40 gal (151 L) are to be supplied.

Propylene glycol or other suitable material can be used as a substitute for priming water to prevent evaporation of the priming fluid and thus reduce ice formation within the system.

A.8.3.3.2 Listed CPVC sprinkler pipe and fittings should be protected from freezing with glycerine only. The use of diethylene glycol, ethylene glycol, or propylene glycol is specifically prohibited. Laboratory testing shows that glycol-based antifreeze solutions present a chemical environment detrimental to CPVC. Listed PB sprinkler pipe and fittings can be protected with glycerine, diethylene glycol, ethylene glycol, or propylene glycol.